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JOHN T. MIDDLETON and C. E. YARWOOD

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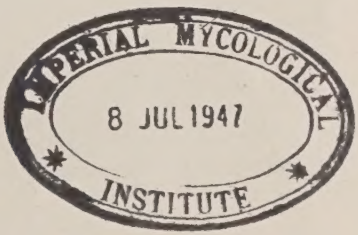

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CONTENTS

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FUNGICIDAL CONTROL OF CANTALOUPE POWDERY MILDEW[1,2]

JOHN T. MIDDLETON[3] and C. E. YARWOOD[4]

INTRODUCTION

POWDERY MILDEW, caused by the fungus *Erysiphe cichoracearum* DC., is the most serious disease of cantaloupes in California. Since it first appeared in the Imperial Valley in 1925, it has been a limiting factor in the production of cantaloupes. In 1936, Powdery Mildew Resistant Cantaloupe No. 45, which

Fig. 1.—Left, a healthy bed of Powdery Mildew Resistant Cantaloupe No. 5. Right, dead vines of a susceptible cantaloupe variety, No. 45. Both varieties were planted in the Imperial Valley on the same date and photographed about 4 months later.

seemed to offer permanent control of the disease, was released coöperatively by the United States Department of Agriculture and the California Agricultural Experiment Station. In 1938, however, a new biological race of the powdery mildew organism appeared, to which No. 45 was highly susceptible, causing great loss to the crops of supposedly resistant cantaloupes during the next few years (fig. 1). Since 1938, new cantaloupe varieties of excellent commercial quality have been produced which are resistant to the two forms of cantaloupe mildew known in the Imperial Valley; these are Nos. 5, 6, and 7. There is always the possibility, however, that strains of the fungus will appear to which these new varieties also are susceptible.

Fungicidal control of powdery mildew therefore appears desirable during periods when suitable resistant varieties are unavailable or are uncertain. It

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[2] Paper No. 537, University of California Citrus Experiment Station, Riverside, California.
[3] Assistant Plant Pathologist in the Experiment Station.
[4] Assistant Professor of Plant Pathology and Assistant Plant Pathologist in the Experiment Station.

is the purpose of this bulletin to present information, based on tests since 1939, which may be used to formulate a spray program to control powdery mildew on susceptible varieties of cantaloupes.

DESCRIPTION OF THE DISEASE

In the Imperial Valley, powdery mildew first appears on cantaloupes usually in February or March and becomes progressively worse until checked in June by hot weather. The first visible signs of the disease are small white circular spots usually found on the lower leaf surface (fig. 2). These powdery

Fig. 2.—Left, a healthy cantaloupe leaf. Right, a diseased leaf showing five powdery mildew colonies or spots. This leaf represents about the 10 per cent level of infection.

mildew colonies, or spots, at first appear to cause no visible injury to the leaf, but as the season advances they increase in number and size, running together until, finally, the white fungus growth may entirely cover the older leaves and stems (fig. 3). Such infected plants become stunted and produce a reduced yield of melons of inferior quality, though the fruits themselves are not infected. Finally, however, the infected leaves and stems turn brown, become brittle and die, and the attached fruits may become sunburned as a result of exposure. Premature ripening is also a result of heavy mildew infection.

Yield records furnish a quantitative indication of losses from powdery mildew in the Imperial Valley. In the three-year period, 1936–1938, just following the introduction of Powdery Mildew Resistant Cantaloupe No. 45, the average yield per acre of marketable cantaloupes was 169 crates whereas the yield for 1939–1940, following the appearance of the new race of cantaloupe powdery mildew, was 93 crates—a yield reduction of 45 per cent attributable to severe infection by powdery mildew.

METHODS OF CONTROL

Experiments on fungicidal control were conducted largely in commercial plantings of No. 45 cantaloupes in the Imperial Valley; a limited acreage of No. 8 and of D-2 was also used. Materials were applied as dusts, as spray concentrates, and as conventional dilute sprays.

Dusting.—Dusts were applied with hand dusters as well as with commercial power dusters. The following dusts represent all general types of dusting materials applied, though not all brands and the lower concentrations used: Butcher Brand Copper Dust No. 20, containing 16 per cent tribasic copper sulfate; Chipman Copper-Hydro Dust A, containing 40 per cent copper hydroxide; Copox-Dust 10 Nico Brand, containing 10 per cent yellow copper oxide; Copper-Dust 102 Nico Brand, containing 20 per cent monohydrated copper sulfate; DuPont Copper A Compound, containing 15 per cent basic copper chloride; 10 per cent Fermate (ferric dimethyl-dithiocarbamate) in

Fig. 3.—Part of a No. 45 cantaloupe vine badly affected with powdery mildew. (From Circular 352.)

Frianite; Lacco Brand Copro Dust No. 165, containing 20 per cent copper oxychloride; Sunland Basic Copper Sulphate Mix 15, containing 15 per cent basic copper sulfate; 6 per cent Spergon (tetrachloroquinone) in pyrophyllite; 20 per cent Zinc Coposil Fungicide (basic copper zinc sulfate) in Frianite; 15 per cent zinc oxide in pyrophyllite; and a dust containing 97 per cent sulfur. Sulfur dust is included here because it is universally successful for the control of most powdery mildews. It gave 97 per cent control of cantaloupe mildew, but reduced the yield of melons by 28 per cent and reduced the green weight of the plants by 40 per cent because of plant injury. No dust other than sulfur gave significant control.

Cantaloupe varieties resistant to injury from sulfur are being developed by various agencies, but these are not necessarily resistant to infection by the powdery mildew fungus. Culture of the sulfur-resistant melon requires application of dusting sulfur when powdery mildew appears in the planting. Inasmuch as sulfur readily controls the disease, these cantaloupe varieties may be grown and maintained relatively free from powdery mildew.

Spraying.—Concentrated copper-oil mixtures were applied as a very fine vapor in an attempt to secure a rapid and economical method of application. Mixtures were compounded using varying amounts of such fungicides as copper sulfate, copper sulfate with hydrated lime, cuprous oxide, and cuprous oxide with iron oxide—all in different combinations with varying quantities

of Triton B-1956 (formerly known as B-1956 spreader emulsifier), Ortho Adhesive, self-emulsifying cottonseed oil, rosin soap, and water. None of these mixtures gave satisfactory control.

A considerable number of dilute fungicidal sprays controlled cantaloupe mildew; the limiting factors in the effectiveness of all sprays tried are proper timing, thorough coverage, and incorporation of a satisfactory wetting agent.

Powdery mildews, unlike most other fungus diseases of foliage, are readily controlled by eradicant sprays, but less readily by protective sprays. Consequently, for best economy of time and materials, it is not desirable to start spraying until some mildew is already present in the field. Experiments have

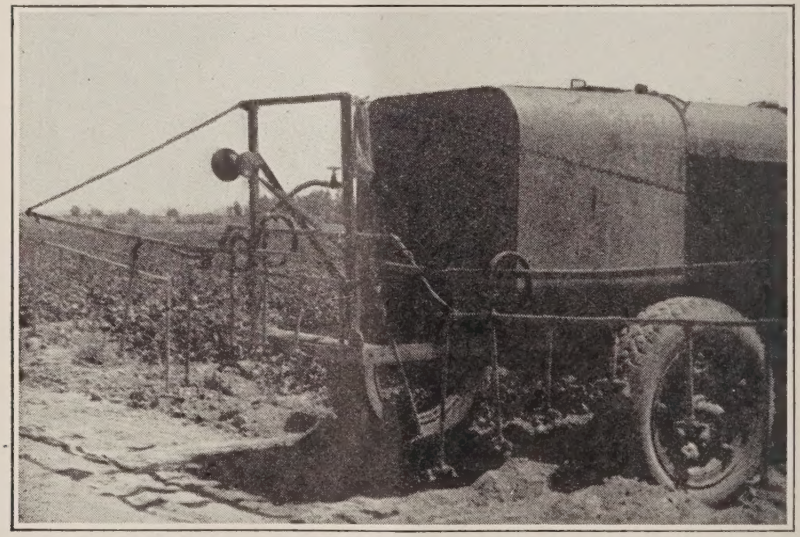

Fig. 4.—Spray equipment used in commercial application of fungicides for the control of cantaloupe powdery mildew. Three beds are sprayed by 12 nozzles per bed. Nozzles are placed to give maximum coverage and minimum leaf whip.

shown that best control is obtained by applying the first spray when approximately 10 per cent of the area of the lower surface of the crown leaves is covered with mildew. Ten per cent infection is usually reached when there are one to five visible colonies per leaf (fig. 2).

On early cantaloupes it is usually advisable to make a second application when mildew again reaches the 10 per cent level of infection; ordinarily this is about 2 weeks after the first application. As a rule mid- and late-season plantings do not require second spray applications. The results of early, medium, and late applications of Bordelo (copper ammonium carbonate), bordeaux, and Cuprocide (cuprous oxide) sprays alone and in all possible time combinations at 2- and 3-week intervals were compared. These tests showed that the early application, when or before the powdery mildew fungus reaches the 10 per cent level of infection, is the most important, that the second is of less importance, and that the third is usually of no value, or possibly is even injurious. A 2-week interval between spray applications gives better control than a 3-week interval.

Because control of cantaloupe mildew is accomplished principally by eradicant action, coverage and thorough wetting are more important than in the use of protective sprays. Adequate coverage is secured by a method involving application of the spray under 250 to 300 pounds' pressure, by the use of a suitable wetting agent such as B-1956, and by employing a spray boom which has a minimum of 12 nozzles per 6-foot bed (fig. 4). The spray is applied at the rate of 250 to 350 gallons per acre, according to the size of the plants. Suitable wetting is obtained when 6 ounces of B-1956 are added to 100 gallons of spray.

Since the fungus is primarily on the lower leaf surface, it is essential that this surface be covered with spray. Proper arrangement of spray nozzles will provide adequate wetting.

EVALUATION OF SPRAY MATERIALS

Representative data on the control of cantaloupe powdery mildew in the Imperial Valley through the use of a variety of spray materials are presented in table 1. These results, taken from different years, different plots, and, in some instances, different methods of application, are not so closely comparable as might be desired; the actual differences are believed to be less than indicated. All of these materials were markedly effective in controlling powdery mildew. Selection of a suitable commercial material depends largely on the danger of plant injury and the cost of material. Wettable sulfur, although the most effective fungicide listed, usually cannot be safely used because of its injury to the plant. Liquid lime-sulfur is extremely effective, economical, and convenient, and was used in a series of dosages of 0.1 to 0.5 per cent. Although dosages of about 0.1 per cent did not cause injury neither did they give adequate control; whereas dosages of 0.3 per cent and over gave excellent control of mildew but caused severe plant injury at temperatures of 95° F and above. Several copper sprays were effective. Copper sulfate, burgundy mixture (copper sulfate plus hydrated sodium carbonate), and bordeaux mixture (copper sulfate plus hydrated lime) are among the most economical. Burgundy is usually more readily applied than bordeaux, because the spray suspension does not clog the screens or the nozzle disks. Cuprocide (cuprous oxide) has been successfully used on a large scale by growers. Burgundy mixture, Spergon, and Orchard Brand Spray Cop (tribasic copper sulfate) have been successfully used commercially but have not been applied on so large a scale as Cuprocide. Copper sulfate was not particularly outstanding in the Imperial Valley, but was effective, without injury, at lower dosages than any other material tried in field and greenhouse tests. On the basis of fruit yield, green weight of vine, and total soluble solids of the fruit, 0.3 per cent liquid lime-sulfur as the first application, followed by 1.5 pounds of Cuprocide in 100 gallons of water as the second application, was the most effective combination tested in the Imperial Valley on early cantaloupes, and may be recommended for general use. However, burgundy or other copper sprays are thought to be approximately as good as Cuprocide in the second application. This sequence of lime-sulfur and copper spray combines the economy and effectiveness of sulfur in the early application with the safety of copper sprays when temperatures are high enough to cause sulfur injury. For medium and late plantings, one application of a copper spray will usually be sufficient.

SUMMARY

For the control of cantaloupe powdery mildew a first spray should be applied when one to five mildew spots per leaf are found on the lower surfaces of the crown leaves. For early-planted cantaloupes a second application should follow when mildew again increases to this same degree of severity, but usually only one application is necessary for medium and late cantaloupes. When temperatures are below 95° F, 38 ounces of liquid lime-sulfur (0.3 gallon) plus 6 ounces of B-1956 per 100 gallons of water is the most economical and one of the most effective sprays used. At temperatures above 95° this lime-sulfur spray is injurious and 1.5–2–100 burgandy or 1.5–100 Cuprocide. plus spreader may be recommended. The highest yield increase in experimental work was secured on early cantaloupes receiving an early spray of liquid lime-sulfur, this process followed 2 weeks later with Cuprocide.

TABLE 1

REPRESENTATIVE RESULTS FROM SPRAY MATERIALS USED FOR THE CONTROL OF CANTALOUPE POWDERY MILDEW

Spray material*	Amount per 100 gallons of water	Per cent reduction in mildew	Per cent increase or decrease in fruit yield	Per cent increase or decrease in green weight of vine	Per cent total soluble solids in ripe fruits
Control, no spray		0	0	0	8.1
Bordeaux mixture	Copper sulfate, 2 pounds; hydrated lime, 2 pounds	91	+35	+76	9.0
Bordelo	2 gallons	94	+65	+43	9.2
Burgundy mixture	Copper sulfate, 1.5 pounds; hydrated sodium carbonate, 2 pounds	95	+32	+41	...
Burgundy mixture (without spreader)	Copper sulfate, 1.5 pounds; hydrated sodium carbonate, 2 pounds	81	+ 9	+25	...
Copper sulfate	2 ounces	68	+28	+47	...
Cuprocide	1.5 pounds	95	+42	+70	9.1
Cupro K	1.5 pounds	53	....	....	...
Fermate	1.5 pounds	71	....	....	...
Liquid lime-sulfur (Baumé 32°)	0.1 gallon	60	+26	+59	...
Liquid lime-sulfur (Baumé 32°)	0.3 gallon	98	−16	−45	...
Liquid lime-sulfur (Baumé 32°), followed by Cuprocide	Lime-sulfur, 0.3 gallon; Cuprocide, 1.5 pounds	93	+96	+87	9.9
Liquid lime-sulfur (Baumé 32°), followed by bordeaux mixture	Lime-sulfur, 0.3 gallon; copper sulfate, 2 pounds; hydrated lime, 2 pounds	94	+54	+66	9.3
Spergon	0.75 pound	89	+19	+22	...
Spray Cop	1.5 pounds	72	....	....	...
Wettable sulfur	3 pounds	100	−42	−40	...

* Six ounces of Triton B-1956 were added per 100 gallons of spray unless otherwise indicated.

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